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Gas meters — Rotary displacement gas meters

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National foreword

This British Standard is the UK implementation of EN 12480:2015. It supersedes BS EN 12480:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GSE/25, Gas Meters.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Foreword

This document (EN 12480:2015) has been prepared by Technical Committee CEN/TC 237 “Gas meters”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2015 and conflicting national standards shall be withdrawn at the latest by September 2015.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12480:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directives.

For relationship with EU Directives, see informative Annex ZA and ZB, which are integral parts of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies ranges, construction, performances, output characteristics and testing of rotary displacement gas meters (hereinafter referred to as RD meters or simply meters) for gas volume measurement.

This European Standard applies to rotary displacement gas meters used to measure the volume of fuel gases of at least the 1st, 2nd and 3rd gas families, the composition of which is specified in EN 437:2003+A1:2009, at a maximum working pressure up to and including 20 bar over an ambient and gas temperature range of at least −10 °C to +40 °C.

This European Standard applies to meters that are installed in locations with vibration and shocks of low significance and in

- closed locations (indoor or outdoor with protection as specified by the manufacturer) with condensing or with non-condensing humidity

or, if specified by the manufacturer,

- open locations (outdoor without any covering) with condensing humidity or with non-condensing humidity;

Unless otherwise specified in this standard:

- all pressures used are gauge;

- all influence quantities, except the one under test, are kept relatively constant at their reference value.

This European Standard also applies to meters with a maximum allowable pressure PS and the volume *V* of less than 6 000 bar · litres or with a product of PS and DN of less than 3 000 bar.

NOTE These limits are the same as in EU directive 97/23/EC.

This European Standard can be used for both pattern approval and individual meter testing. Cross-reference tables are given in:

- Annex A for the tests that need to be undertaken for pattern approval;

- Annex B for individual meter testing.

Some parts of this standard cover meters with mechanical index only.

The risk philosophy adopted in this standard is based on the analysis of hazards on account of pressure. The standard applies principles to eliminate or reduce hazards. Where these hazards cannot be eliminated appropriate protection measures are specified.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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EN 10088-1:2014, *Stainless steels - List of stainless steels*

EN 10088-3:2014, *Stainless steels - Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes*

EN 10111:2008, *Continuously hot rolled low carbon steel sheet and strip for cold forming - Technical delivery conditions*

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EN ISO 15614-1:2004, *Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004)*

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ASTM A 276:2010, *Standard Specification for Stainless Steel Bars and Shapes*

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ASTM A 420/A 420M:2006, *Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service*

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ASTM A 536:2009, *Standard Specification for Ductile Iron Castings*

ASTM A 564/A 564M:2010, *Standard Specification for Hot Rolled and Cold Finished Age Hardening Stainless Steel Bars and Shapes*

ASTM A 694/A 694M:2008, *Standard Specification for Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High Pressure Transmission Service*

ASTM A 707/A 707M:2010, *Standard Specification for Forged Carbon and Alloy Steel Flanges for Low Temperature Service*

ASTM A 874/A 874M:2009, *Standard Specification for Ferritic Ductile Iron Castings Suitable for Low Temperature Service*

ASTM B 85/B 85M:2010, *Standard Specification for Aluminum Alloy Die Castings*

ASTM F 593:2008, *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs*

ASTM F 594:2009, *Standard Specification for Stainless Steel Nuts*

3 Terms and definitions

3.1 Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
accuracy class 1,0
accuracy achieved by a meter, which has an error of indication between −2 % and +2 % for flow rates Q, where $Q_{min} \leq Q < Q_t$, and an error of indication between −1 % and +1 % for flow rates Q, where $Q_t \leq Q \leq Q_{max}$

3.1.2
cyclic volume
volume of the gas measured by one complete revolution of the element(s)

3.1.3
density of gas
mass of gas divided by the volume

3.1.4
allowable design temperature range
range of gas temperatures(minimum to maximum) for which the meter is designed as declared and marked on the meter

3.1.5
diameter
nominal size of diameter

3.1.6
error of indication
value which shows the relationship in percentage terms of the difference between the volume indicated by the meter and the volume which has actually flowed through the meter, to the latter value:

where

$$E = \frac{V_i - V_c}{V_c} \cdot 100$$

*V*i is the indicated volume and *V*c is the volume which has actually flowed through the meter

3.1.7
maximum allowable design pressure
maximum pressure for which the meter is designed as specified by the manufacturer

3.1.8
Minimum flow rate
lowest flow rate at which the gas meter provides indications that satisfy the requirements regarding maximum permissible error (MPE)

3.1.9
maximum flow rate
highest flow rate at which the gas meter provides indications that satisfy the requirements regarding maximum permissible error (MPE)

3.1.10
meter family
group of meters of different sizes but with similar construction (see Annex H)

Note 1 to entry: By specifying a meter family it is possible to reduce the number of tests and documents during assessment.

3.1.11
metering conditions
conditions of the gas prevailing at the point of measurement

3.1.12
metering pressure
absolute pressure at which the volume of the gas is measured

3.1.13
normal conditions of use
conditions referring to the meter operating:

- within the range of working pressure
- within the operational temperature and gas temperature range

- with the distributed gas

3.1.14
operating pressure range
limits of working pressure, as declared by the manufacturer, for which the meter will continue to operate within its metrological characteristics

3.1.15
operating temperature range
range of gas and ambient temperatures for which the meter satisfies the metrological requirements of this standard

3.1.16
overload flow rate
highest flow rate at which the meter operates for a short period of time without deteriorating

3.1.17
pressure loss
non-recoverable pressure drop caused by the presence of the meter in the pipeline

3.1.18
rotary displacement meter (RD meter)
gas volume meter in which a rigid measuring compartment is formed between the walls of a stationary chamber and rotating element or elements

Note 1 to entry: Each rotation of the element(s) displaces a fixed volume of gas which is cumulatively registered and indicated by an indicating device. It is designed to measure, memorize and display the volume of a fuel gas that has passed through it.

3.1.19
storage temperature range
range of temperatures at which the meter can be stored without being adversely affected

3.1.20
transitional flow rate
flow rate occurring between the maximum and minimum flow rates at which the flow rate range is divided into two zones, the upper zone and the lower zone, each zone having a characteristic MPE

3.1.21
volume of meter
internal volume of meter excluding the volume of internal parts

3.1.22
working pressure
pressure of the gas at the inlet of the meter

3.1.23
limit pressure
pressure at which yielding becomes apparent in any component of the meter or its fixtures

3.1.24
safety factor body
ratio of the limit pressure pl to the maximum allowable pressure PS applied to the meter body

3.1.25
safety factor others
ratio of the limit pressure pl to the maximum allowable pressure PS applied to other pressure containing parts of the meter

3.2 Symbols and abbreviations

Table 1 — Symbols

Symbol	Represented quantity	SI Unit
Vcyc	cyclic volume	dm^3
ρ	Density of gas	$kg \cdot m^{-3}$
TS	Allowable design temperature range	°C
DN	Diameter	Dimensionless
E	Error of indication	%
MPE	Maximum permissible error	%
WME	Weighted mean error	%
PS	Maximum allowable design pressure	bar
Q	flow rate	m^3/h
p_m	Metering pressure	bar
p	Operating pressure range	bar
t	Operating temperature range	°C
Q_r	Overload flow rate	m^3/h
ts	Storage temperature range	°C
Q_t	Transitional flow rate	m^3/h
V	Volume of meter	L
pl	Limit pressure	bar
S_b	Safety factor body	Dimensionless
S	Safety factor others	Dimensionless
Subscripts		
m	Metering conditions of the gas	
min	Minimum	
max	Maximum	
i	Indicated	
t	Transitional	

4 Operating range

4.1 General

Gas meters shall be classified according to accuracy class 1,0. The values of maximum flow rates and the corresponding values of the upper limits of the minimum flow rates shall be one of those given in 4.2, when the meter is tested with air of density approximately 1,2 kg/m^3.

4.2 Flow rate range (conformity/individual)

Unless specified by the purchaser, the values of the maximum and minimum flow rate of rotary displacement gas meters are decimal multiples and sub-multiples of these values.

For example for one decade:

Q_{max} (m^3/h): 100, 160, 250, 400, 650

Q_{min} (m^3/h): 10, 13, 16, 20, 25, 32, 40, 50, 65, 80

With $Q_{max} \geq 20\ Q_{min}$

4.3 Operating pressure range (conformity/individual)

The upper limit of the operating pressure range shall not exceed the maximum allowable design pressure. The operating pressure range stated by manufacturer shall be marked on the meter.

4.4 Operating temperature range (conformity/individual)

All meters shall be capable of meeting the requirements in 5.6 for the following: gas; ambient; storage; design temperature ranges:

- a minimum ambient temperature range of –10 °C to 40 °C.

NOTE a wider ambient temperature range using a minimum temperature of –10 °C, –25 °C, or –40 °C and a maximum temperature of 40 °C, 55 °C, or 70 °C may be used.

- a minimum gas temperature range of 40 K (the gas temperature range shall be within the ambient temperature range);

- a minimum storage temperature range of –20 °C to 60 °C (see Clause 5.6) (the storage temperature range may be wider than or equal to the ambient temperature range).

The operating temperature range shall be inside the limits of the allowable design temperature range. The operating temperature range stated by manufacturer shall be marked on the meter.

5 Metrological performance

5.1 General

The uncertainty of the test rig (best measurement capability) shall be at a maximum of 1/5 of the MPE for the initial pattern approval test and at a maximum of 1/3 of the MPE for the individual meter testing.

5.2 Error of indication (conformity/individual)

5.2.1 Requirements

When tested in accordance with 5.2.2, the meter error of indication shall be within the limits specified in Table 2.

Table 2 — Limits of maximum permissible errors

Flow rate Q m^3/h	Maximum permissible errors
$Q_{min} \leq Q < Q_t$	±2 %
$Q_t \leq Q \leq Q_{max}$	±1 %

Transitional flow rate values, Q_t, shall be taken from Table 3·

Table 3 — Transitional flow rate values

Q_{max} / Q_{min}	Q_t
$20 \leq Q_{max} / Q_{min} \leq 30$ $Q_{max} / Q_{min} > 30$	$0{,}20\ Q_{max}$ $\leq 0{,}10\ Q_{max}$

The gas meter shall not exploit the MPEs or systematically favour any party.

Each meter shall be adjusted so that the weighted mean error (*WME*) is as close to zero as the adjustment and the maximum permissible errors allow.

The *WME* shall have a value between −0,4 % and +0,4 %.

The *WME* is calculated as follows:

$$\mathrm{WME} = \frac{\Sigma(Q_i / Q_{max}) \cdot E_i}{\Sigma(Q_i / Q_{max})}$$

where:

Qi / Q_{max} is a weighting factor;

Ei is the error of indication at the flow rate QI given as a percentage.

When Qi = Q_{max} a weighting factor of 0,4 instead of 1 shall be used.

5.2.2 Test

The test is carried out using air (density 1,2 kg m-^{3}), or gas specified in the scope, at normal ambient conditions. The meter is tested at the following flow rates (±10 %):

a) pattern approval:

   1) For meters with flow rate range between 1:20 to 1:30:

   Q_{min}; 0,05 Q_{max} (when this value is larger than Q_{min}) ; 0,1 Q_{max}; 0,25 Q_{max}; 0,4 Q_{max}; 0,7 Q_{max}; Q_{max}.

   2) for meters with a flow rate range ≥ 1:50:

   Q_{min}; 0,05 Q_{max}; 0,15 Q_{max}; 0,25 Q_{max}; 0,40 Q_{max}; 0,70 Q_{max}; Q_{max}.

b) individual factory testing for error of indication (every meter shall be tested) at the flow rates indicated in Table 4:

When requested by the customer, the error of indication test can be carried out at specified conditions (close to the expected operational conditions).

If the test point is equal to Q_t, the tighter limit of the error of indication has to be applied.

Table 4 — Test points for individual meter testing

Q_{max} / Q_{min}	Q_{min}	0,015 Q_{max}	0,05 Q_{max}	0, 25 Q_{max}	Q_{max}
$20 \leq Q_{max} / Q_{min} < 30$	X			X	X
$30 \leq Q_{max} / Q_{min} < 160$	X		X	X	X
$Q_{max} / Q_{min} \geq 160$	X	X	X	X	X

5.3 Pressure loss (conformity/individual)

5.3.1 Requirements

When tested in accordance with 5.3.2, the maximum pressure loss at Q_{max}, when using air with density 1,2 $kg.m^{-3}$, shall be declared by the manufacturer.

5.3.2 Test

The pressure loss shall be measured between a point 1 DN upstream and a point 1 DN downstream of the meter, on piping of the same DN as the meter.

Care shall be taken on selection and manufacturing of the pressure tappings to ensure that flow pattern distortions do not affect the pressure readings.

5.4 Metrological repeatability (conformity)

5.4.1 Requirements

When tested in accordance with 5.4.2, in the flow range Q_{min} – Q_{max} the variation of error of indication at each flow rate shall stay within the range:

$Q_{min} \leq Q < Q_t$ 1/3 MPE

$Q_t \leq Q \leq Q_{max}$ 1/5 MPE

5.4.2 Test

The error of indication of the meter shall be determined at Q_{min}, the flow shall then be increased to at least Q_t, and then returned to Q_{min} and the error of indication determined.

This process shall be repeated and the error of indication at Q_{min} determined again.

Check that the three successive errors of indication at Q_{min} are within 0,33 MPE.

This test may be combined with the test described below for determining the repeatability from Q_t to Q_{max}.

The error of indication of the meter is determined at two flow rates in the following order: Q_t, Q_{max}, Q_t, Q_{max}, Q_t, Q_{max}, where the change from Q_t to Q_{max} is done via 1,10 Q_{max}, in order to approach Q_{max} from a higher flow rate.

The cycle is repeated six times. The test shall be carried out with air, or gas, at atmospheric conditions (±100 mbar).

Check that the six resulting errors of indication at each flow rate are within a span of 0,2 %, excluding any interaction between the meter and the test bench.

5.5 Operating pressure (conformity/individual)

5.5.1 General

The manufacturer shall declare the maximum operating pressure for which the meter can be used without additional high-pressure calibration. Above this declared pressure, additional high pressure calibration shall be undertaken.

5.5.2 Requirements

a) For pattern approval, when tested in accordance with 5.5.3 a), the meter shall comply with 5.2.1.

b) Using the same meter as in a) above, when tested in accordance with 5.5.3 b), at the manufacturer's declared maximum operating pressure it shall be confirmed that the meter complies with 5.2.1.

c) For individual test, when tested in accordance with 5.5.4, the manufacturer's declared maximum operating pressure shall be confirmed.

5.5.3 Pattern approval test

a) One meter of each meter family is tested following 5.2.2 a).

b) Test the meter at 10 different flow rates equally distributed between Q_t and Q_{max} at the declared maximum operating pressure.

5.5.4 Individual test

No additional test is required when the meter is used within the declared maximum operating pressure.

Above this declared maximum operating pressure, an error of indication test is carried out at the specified conditions (close to the operational conditions).

When requested by the customer, the error of indication test can be carried out at specified conditions (close to the operational conditions) even where the pressure is inside of the pressure range for this meter type.

5.6 Temperature ranges (conformity)

5.6.1 General

5.6.1.1 Requirement

A meter of a meter family with the highest expected temperature dependency shall be tested in accordance with 5.6.1.2, the measured errors of indications shall be within the MPE given in 5.2.1.

Where testing at high flow rates is not practical, when undertaking the test, the gas meter shall be tested at one temperature limit or both limits at all test flow rates according to 5.2.2 a) except at 0,7 Q_{max} and Q_{max} (or except Q_{max} only).

For all test flow rates above Q_t, the differences in the measured errors of indication at normal ambient conditions (see 5.2.2a) shall be calculated. These differences shall not vary by more than 0,2 %. Furthermore, the average difference shall be calculated. Assuming that this average difference is valid for the flow rates which have not been tested, the errors of indication at these flow rates range shall be within the MPE.

5.6.1.2 Test

Test the meter at the upper specified gas temperature and at the lower specified gas temperature ensuring that the temperatures do not differ by more than 2°K from the specified temperatures. Determine the error of indication at both temperatures for the flow rates which are specified in 5.2.2 a).

5.6.2 Minimum operational temperature

5.6.2.1 Requirement

When tested in accordance with 5.6.2.2, the meter shall start to rotate at a flow rate not exceeding Q_{min}, and continue to rotate for not less than one complete revolution with a pressure loss not exceeding 0,1 mbar.

5.6.2.2 Test

— cool the meter down to minimum operational temperature, until stabilized ;

— start the meter at a flow rate not exceeding Q_{min} with air (or equivalent medium) at ambient temperature.

5.6.3 Maximum operational temperature

5.6.3.1 Requirement

When tested in accordance with 5.6.3.2, the meter shall start to rotate at a flow rate not exceeding Q_{min}, and continue to rotate for not less of one complete revolution with a pressure loss not exceeding 0,1 mbar.

5.6.3.2 Test

— heat the meter at maximum operational temperature, until stabilized ;

— start the meter at a flow rate not exceeding Q_{min} with air (or equivalent medium) at ambient temperature.

5.6.4 Storage temperature range

5.6.4.1 Requirement

When tested in accordance with 5.6.4.2 a), the error of indication shall be within the maximum permissible error and the meter shall not display a shift in excess of 0,4 % and not show signs of deterioration.

When tested in accordance with 5.6.4.2 b), the error of indication shall be within the maximum permissible error and the meter shall not show signs of deterioration.

5.6.4.2 Test

a)

- cool the meter to the minimum storage temperature, until stabilized ;
- take the meter back to ambient temperature, until stabilized;
- perform again the error of indication test as indicated in 5.2.2 a and carry out a visual inspection.

b)

- heat the meter to the maximum storage temperature, until stabilized ;
- take the meter back to ambient temperature, until stabilized;

— perform again the error of indication test as indicated in 5.2.2 a and carry out a visual inspection.

5.7 Condensing ambient conditions (conformity)

5.7.1 Requirements

After testing in accordance with 5.7.2 the error of indication shall remain within the initial maximum permissible error limits specified in Table 2 and the index and markings shall remain legible.

5.7.2 Test

Test one meter for error of indication in accordance with 5.2.2 a) and then test in accordance with EN ISO 6270-1 for a duration of 340 hours. Re-test the meter for error of indication in accordance with 5.2.2 a) and visually inspect for legibility of the index and the markings.

5.8 Bidirectional meters (conformity)

5.8.1 Requirements

When tested in accordance with 5.8.2, meters designed for both flow directions shall conform to the metrological performances described in 5.2.1 for both directions.

5.8.2 Test

The test meter is tested following 5.2.2 a), adjusted following 5.2.1. The meter is turned in the opposite flow direction and tested again following 5.2.2 a.)

5.9 Influence of oil filling (conformity)

5.9.1 Requirements

Where the meter is designed for operating with oil filling, after testing in accordance with 5.9.2 the influence of oil filling is lower than 1/3 of MPE. For meters meeting this requirement the individual meter calibration, 5.2.2 b shall be performed without oil filling.

5.9.2 Tests

At least one meter from each meter family shall be tested for error of indication in accordance with 5.2.2 a with oil filling. The same meter shall be tested with the oil drained: Check that the MPE differences between the two tests doesn’t exceed 1/3 of the MPE for each tested flow rate.

6 Design and manufacturing

6.1 General (conformity/individual)

A gas meter shall be designed, manufactured and checked by the manufacturer to ensure it meets the requirements of this standard. The manufacturer shall provide instructions, covering installation, commissioning and maintenance to ensure its safety and correct functionality in service under all reasonably foreseeable conditions.

Materials for the pressurized parts of the meter shall not be significantly affected by ageing during the expected life of the meter and be suitable for its intended purpose.

The design shall take in account the following:

- Operating pressure range

- Operating temperature range
- Protection against corrosion
- Penetration resistance
- Reaction forces on bodies and flanges

The gas meter shall be constructed in such a way that any mechanical interference, capable of affecting the meter error of indication, results in permanently visible damage to the meter, or its sealing or protection marks.

For use in open location, the meters shall fulfil the specification in Annex G.

A sealing drawing is part of the documentation for type pattern approval. It shall include the metrological sealing as well as the sealing of all metrological relevant removable accessories.

6.2 Material

6.2.1 General (conformity)

The meter body and the internal mechanism shall be manufactured of materials suitable for the service conditions, and resistant to attack from the fluids which may pass through the meter.

Exterior surfaces of the meter shall be protected, if necessary, against corrosion.

The meter body and all other parts shall be constructed of sound materials designed to handle the pressure and temperatures for which they are rated.

6.2.2 Design method

The gas meter shall be designed for adequate strength based on a calculation method according to EN 12516-2 (steel) or EN 12516-4 (non-steel),- supplemented by an experimental design method, or an experimental design method without calculation according to EN 12516-3.

6.2.3 Resistance to external corrosion

All parts of the meter shall be able to resist any corrosive substances contained in the external atmosphere with which they may be in contact during normal conditions of use.

Where necessary, meters shall be provided with a suitable coating to protect against corrosion. Any such protective coating shall meet the requirements of 6.2.4 and 6.2.5.

6.2.4 Penetration resistance

6.2.4.1 Requirements

When tested in accordance with 6.2.4.2, the base material shall not be exposed.

6.2.4.2 Test

The penetration resistance of the protective coating is assessed as described in EN ISO 1518-2:2011, 5.1.

The following parameters apply:

— a loading of 29,4 N

— a speed of 30 $mm.s^{-1}$ to 40 $mm.s^{-1}$

— Penetration specified to the substrate

An alternative apparatus to that given in EN ISO 1518-2:2011, 5.1 is shown in Figure 1.

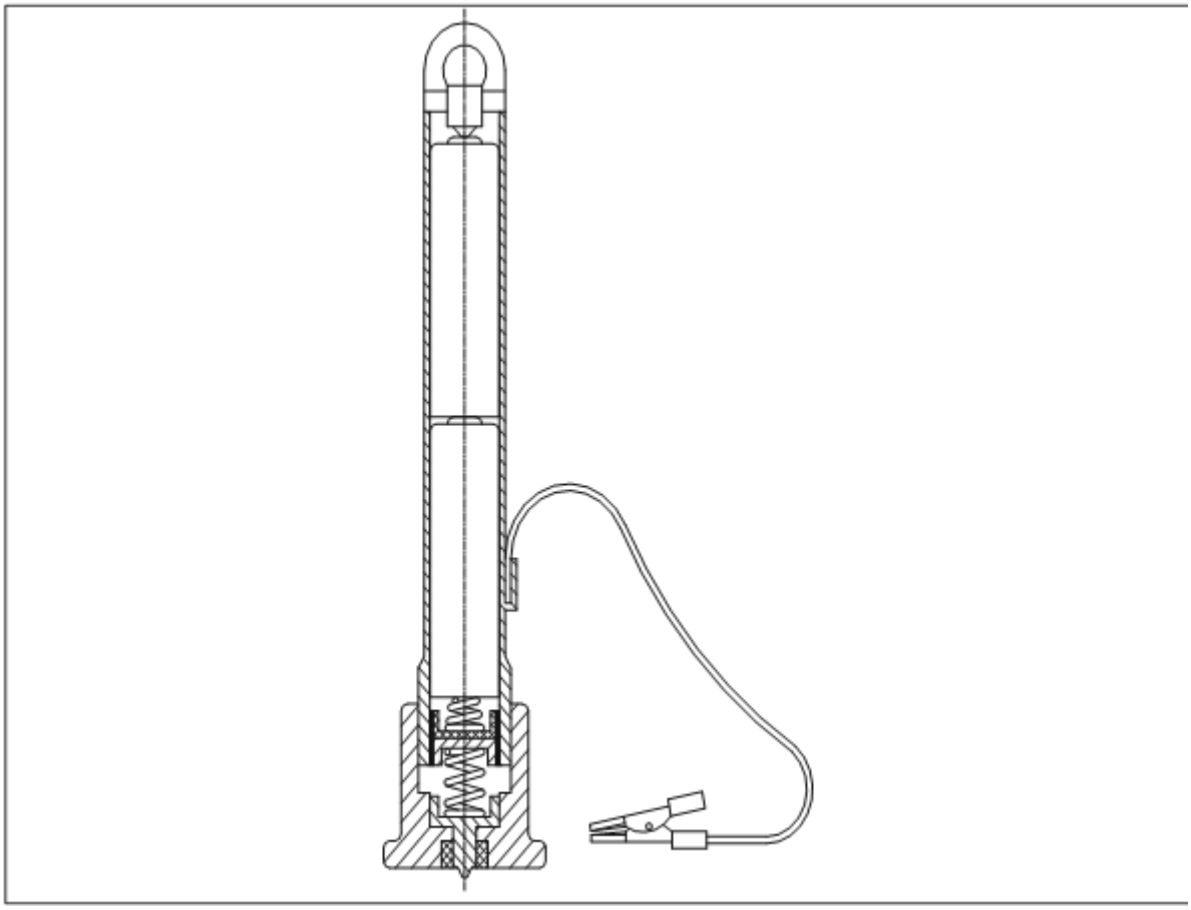


Figure 1 — alternative to the penetration resistance test apparatus

6.2.5 Adhesion of the protective coating

6.2.5.1 Requirements

When tested in accordance with 6.2.5.2, there shall be no detachment of any complete protective coated square.

6.2.5.2 Test

The protective coated surface of the meter or representative sample is tested in accordance with EN ISO 2409.

6.2.6 Materials for pressurized parts

6.2.6.1 General

Pressure containing parts shall be constructed with materials suitable for the scheduled lifetime of the meter unless replacement is foreseen. Such materials shall be verified according to the following requirements:

— Materials shall comply with harmonized standards (see Table F.1) **or**

— Materials shall be covered by a European conformity assessment of pressure equipment materials, **or**

— Materials shall be subject of a particular material appraisal.

— In all cases, the restrictions given in tables of Annex F and the safety factors in Table 5 shall be met.

— Steel is considered as sufficiently ductile if its elongation after rupture is no less than 14 % and its bending rupture energy is no less than 27 Joule at the lowest operating temperature.

Materials used in similar applications under similar operating conditions, which have been recognized as being safe to use before 29 November 1999 are also be regarded as suitable. The safety of gas meters using such materials shall be verified in combination with the design assessment. Pressurized parts shall be designed for loadings appropriate to their intended use and other reasonable foreseen operating conditions.

Pressurized parts shall meet the requirements of 6.2.6.3.1.

NOTE For a list of materials used for the construction of pressure equipment and recognized as being safe to use before 29 November 1999, see Table F 2.

6.2.6.2 Non-destructive testing (NDT)

Meter bodies which are to be non-destructively tested shall be in accordance with Annex E.

6.2.6.3 Strength of housings

6.2.6.3.1 Body

The limit pressure *p*l and maximum allowable pressure PS shall be as follows:

$$p\mathrm{l} \geq S_\mathrm{b} \cdot \mathrm{PS}$$

The design shall also take in account the possible stress during transportation and handling (minimum thickness and geometry...)

6.2.6.3.2 Flanges

The maximum allowable operating pressure for flanges in accordance with the relevant parts of ISO 7005-1:2011 and ISO 7005-2:1988 shall not be less than maximum allowable pressure PS. Flanges shall be in accordance with following appropriate standards: EN 1092-1:2007+A1:2013; EN 1092-2:1997; EN 1092-3:2003; EN 1092-4:2002; EN 1759-1:2004; EN 1759-3:2003; EN 1759-4:2003.

6.2.6.3.3 Other pressure containing parts for rotary piston meters

Those parts subjected to pressure under normal operating conditions, or those that become pressure containing parts in the event of a failure, shall have a limit pressure *p*l and a maximum allowable pressure PS, complying with the following requirement: $p\mathrm{l} \geq S \cdot \mathrm{PS}$.

6.2.6.3.4 Minimum values of safety factor

The values listed in Table 5 shall be used to limit the stresses in the walls of pressure containing parts at the maximum allowable pressure.

Table 5 — minimum values of safety factor

Group of materials	Minimum value of safety factor	
	S	For parts of the body stressed by forces from pipelines only S_b
Rolled and forged steel	1,7	2,13
Cast steel	2,0	2,5
Spheroidal graphite cast iron and malleable cast iron	2,5	3,13
Copper-zinc wrought alloys and aluminium wrought alloys	2,0	2,5
Copper-tin cast alloys and copper-zinc cast alloys	2,5	3,13
Aluminium cast alloys A_{min} 4 %	2,5	3,13
Aluminium cast alloys A_{min} 1,5 %	3,2	4,0

6.2.6.3.5 Welded joint coefficient

For welded joints in pressure containing parts, the welded joint coefficient shall not exceed the following values:

— for meters subject to NDTs which confirm that the whole series of joints show no significant defects, the value of 1;

— for meters subject to random NDTs, the value of 0,85;

— for meters not subjected to NDTs other than visual inspection, the value of 0,7.

6.3 Robustness

6.3.1 Resistance to internal pressure (conformity/individual)

6.3.1.1 Requirements

The meter case shall be designed to withstand the internal pressure using a recognized appropriate safety factor for the case material and maximum allowable pressure PS. Alternatively, it shall be tested to ensure it has sufficient strength to operate in safety. The meter casing pattern approval is specified in 6.3.1.2, option 2.

Experimental design shall be in accordance EN 12516-3:2002. An index window which, in normal operation, is subjected to the gas pressure shall be tested for gas tightness with the casing.

Each meter casing and all other parts forming the pressure containing structure of the meter shall be subjected to the strength test specified in 6.3.1.3. An appropriate certificate shall be delivered by the manufacturer with each meter, certifying conformity with this clause.

The meter manufacturer shall ensure all relevant material certificates are available.

6.3.1.2 Test (conformity)

The manufacturer is responsible for all aspects including design, manufacture inspection, and testing.

Option1:

Records of all design calculations shall be available for inspection to ensure that the materials and design of the meter case comply with a recognized pressure vessel standard. The design calculation shall:

— take into account the static head and dynamic gas pressures;

— fulfil the strength requirements at the minimum and maximum operational allowable temperature (TS) according to the temperature class of the meter as described in 4.4;

— use values appropriate to the properties of the materials being used.

Option 2:

A hydrostatic test shall be performed at a pressure which will produce equivalent stresses to a pressure of at least four times the maximum allowable pressure (PS), being applied to a meter with minimum specified wall thickness at the most stressful design temperature (TS). In this test the pressure shall be maintained continuously for 30 min without the case yielding. The test shall be performed at a temperature of (20 ± 5) °C (nominal) and the procedures and results shall be recorded and available to the test authority, or others, if requested. For each nominal diameter, one sample meter shall be tested.

6.3.1.3 Individual factory testing (conformity/individual)

The test equipment shall not subject the meter to externally applied stress which may significantly affect the result of this test.

At the discretion of the test facility, the test can be carried out with water, kerosene or any other suitable liquid having a viscosity not greater than that of the water; or with gas (air or any other suitable gas). The meter shall be free of entrapped air when testing with a liquid.

If meters are to be subjected to a pneumatic test, organizations shall take any necessary precautions to safeguard the safety of personnel in carrying out this test. This may include prior hydrostatic testing of pressure containing components.

The test shall be performed at a minimum internal pressure of 1,5 times the maximum allowable pressure with a minimum of 2 bar.

The test shall be performed by applying pressure inside the assembled meter casing with all the connection closed. Detectable leakage through the casing is not acceptable. The test duration shall be 180 s.

If pressure tests in presence of a representative of the purchaser are specified, painted meters from stock may be re-tested without removal of paint.

6.3.2 Fire resistance (conformity)

If the manufacturer declares that the meter is resistant to high temperatures the meter shall comply with Annex C.

6.3.3 External leak tightness (conformity/individual)

6.3.3.1 Requirements

When tested in accordance with 6.3.3.2, the meter shall be leak tight under normal conditions of use within the range of working pressures.

6.3.3.2 Test

The meter is tested for leakage prior to the application of any external coating or painting capable of sealing against any eventual leakage. Parts shall be free from deposits, oxides, welding slag or other process material. Chemical corrosion protection treatments and internal linings are permitted.

When the pressure tests are required in the presence of the purchaser's representative, painted meters may be re-tested without removal of either coating or paint.

The sensitivity level of the leakage detection test equipment shall be 0,1 $mm^3.(s.DN)^{-1}$ or better. The test equipment shall not subject the meter to external applied stresses which may affect the test result.

The completely assembled gas containing parts shall be pneumatically tested for external leakage at a minimum internal pressure of 1,1 times the maximum working pressure, with a minimum of 0,5 bar. The pressure shall be increased slowly up to the test pressure, at a rate not exceeding 350 $mbar.s^{-1}$, unless otherwise specified by the manufacturer.

The test pressure shall be maintained for a minimum of 180 s, during which time there shall be no detectable leakage.

If a leakage test is carried out after a hydrostatic test, the meter shall be completely dried prior to assembly and test, to avoid the possible effects of a water seal.

The meter shall be de-pressurized at a rate not exceeding that of pressurization.

6.3.3.3 Test fluid

The test shall be carried out using air, nitrogen or other inert gases. The test fluid shall be free from oil, grease and moisture.

6.3.4 Overload (conformity)

6.3.4.1 Requirements

When tested in accordance with 6.3.4 2, the maximum allowable shift of the error of indication at each flow rate shall not exceed 1/3 of the maximum permissible errors given in Table 2, and the error shall remain within the limits of the maximum permissible error.

6.3.4.2 Test

The meter is run at 1,2 Q_{max} for 30 min with air of density of 1,2 $kg.m^{-3}$, then the error of indication test shall be performed again in accordance with 5.2.2 a.

6.3.5 Bending and torsional moment (conformity)

6.3.5.1 Requirements

When tested in accordance with 6.3.5.2,

a) the error of indication at Q_{min} flow rate shall remain within the initial allowable values (see 5.2.1);

b) the error of indication shall not exceed the limit specified in Table 2, and the shift at each flow rate not exceed 1/3 of the MPE;

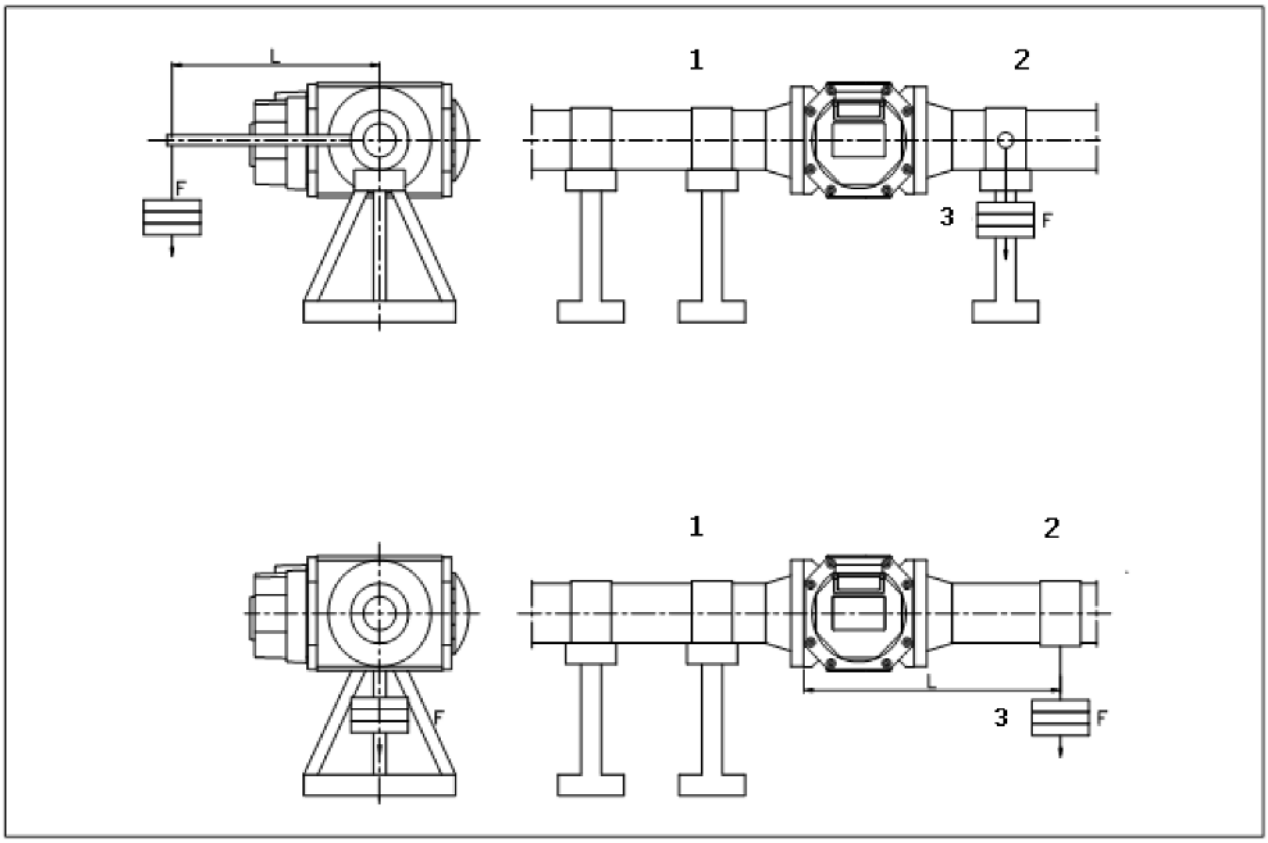
c) the meter shall not show any evidence of leaks or loss of pressure and remain in accordance with 6.3.3.1;

d) the alignment between the two faces of the flanges shall not have changed by more than 0,5°;

e) the alignment between the holes or reference point on the flanges shall not have changed by more than 0,5°.

6.3.5.2 Test

Assemble the meter on the apparatus (or similar) as shown in Figure 2.



Key

1 inlet pipe

2 outlet pipe

3 load

Figure 2 — Example of arrangement for torsional and bending moment

The apparatus consists of a lever arm of predetermined length to which a force, in addition to the weight of the meter, can be applied in a perpendicular plane for performing the torsional and bending moment tests (one pipe shall be supported and the torque applied on the other one, as shown in Figure 2).

Carryout the following sequence:

- measure the alignments of the flanges and the corresponding holes or reference points of the two flanges;
- undertake a gas tightness test in accordance with 6.3.3.2;
- ensure the meter meets the requirements of 5.2.1 using the error of indication test given in 5.2.2 a);

- apply a bending moment to the flange according to the values given in Table 6, for duration not less than 1 min., measure the error of indication at Q_{min} as described in 5.2.2 a) and record the result (see requirement a));
- remove the bending moment;
- apply a torsional moment to the flange according to the values given in Table 6, for duration not less than 1 min., measure the error of indication at Q_{min} as described in 5.2.2 a) and record the result (see requirement a));
- remove the torsional moment;
- ensure the meter meets the requirements of 5.2.1 using the error of indication test given in 5.2.2 a) (see requirement b));
- undertake a leakage test in accordance with 6.3.3.2 (see requirement c));
- measure the alignments of the flanges and the corresponding holes or reference points of the two flanges. (see requirements d) and e));

Table 6 — Torsional and bending moment applied to the meter

Pipe size (DN)	Moment (N.m)
25	290
40	390
50	440
80	760
100	1 220
150	2 710
200	4 470
250	7 050

6.4 Transportation and storage (conformity/individual)

6.4.1 Protection against foreign matter

6.4.1.1 Requirement

When tested in accordance with 6.4.1.2, it shall be shown that the meter connections are fitted with suitable covers to prevent the entry of foreign matter during transportation and storage,

6.4.1.2 Test

The meter is subject to visual inspection.

6.4.2 Protection against damage

6.4.2.1 Requirements

When tested in accordance with 6.4.2.2 the meter shall withstand the handling required during its transport and installation. After the test it shall comply with the following requirements:

a) errors shall be within MPE

b) external leak tightness shall be in accordance with 6.3.3.1.

6.4.2.2 Test

Ensure the meter meets the requirements of 5.2.1 by using the test given in 5.2.2 a), and test to ensure it meets 6.3.3. Place the meter in its transportation packaging.

The meter shall be dropped vertically, from rest, on to a flat, hard, horizontal floor from a height of 0,2 m. The dropping positions are selected to prevent damage to external accessories of the meter.

Retest the meter to ensure it meets the requirements of 5.2.1 by using the test given in 5.2.2 a), and test to ensure it meets 6.3.3

6.5 Connections (conformity)

The inlet and outlet connections of the meter shall have the same nominal diameter (DN) and connection type, flanges shall correspond to ISO 7005-1:2011 and ISO 7005-2:1988.

The lengths in millimetres, corresponding to nominal connection diameter sizes (DN) are given in Table 7.

Tolerances of the distance between connections, as given by the manufacturer, the planes parallel and the distance between connections axes are given in ISO 2768-1:1989, class c.

Table 7 — face to face dimensions (mm) for meters with flanged or screwed connections(preferable combinations are underlined in bold)

DN 25 to 50	DN 80	DN 100	DN 150	DN 200	DN 250	DN 300
121	**171**	230	241	400	630	711
150	230	**241**	260	533	711	900
171	**241**	340	340	600		
241	270	400	400			
	310		406			
	320		450			
			457			
			630			

6.6 Pressure and temperature tappings (conformity)

6.6.1 Pressure tappings

A meter shall have a tapping for measuring the pressure at the inlet of the meter, the p_m point, which shall be known as the metering pressure.

A second tapping shall be located downstream of the measuring chamber. The bore diameter for the pressure measurement shall not be less than 3 mm.

The pressure tappings shall be designed in such a way that the pressure measured reflects the metering conditions.

Pressure tappings shall be provided with a means of closure so as to make them gas-tight, and a sealing provision shall be provided, if requested.

Pressure tapping dimensions shall be 1/4 NPT.

6.6.2 Temperature tappings

6.6.2.1 General

A meter may be fitted with temperature tappings allowing the measurement of the gas temperature passing through the meter.

They shall be located to ensure that the measured temperature is representative of the mean gas temperature at the measuring chamber.

Where it is intended to use temperature measuring systems which protrude into the meter flow passages, the meter shall be calibrated with its thermowell or sensor installed. This procedure is not necessary if, at the pattern approval stage, evidence is produced that the presence of the sensor and/or thermowell has negligible influence on the metrology of the meter.

Temperature tappings shall be able to accommodate a thermowell suitable for a Ø 6 mm temperature sensor.

6.6.2.2 Requirements

When tested in accordance to 6.6.2.3 the meter error at each test flow shall not shift more than 1/3 of the maximum permissible error, as defined in Table 2. The meter shall meet the requirements of 5.3.1 when fitted with a thermowell or sensor.

6.6.2.3 Test

Two errors of indication tests are performed in accordance with 5.2.2a, one with and one without the sensor/thermowell fitted. During the above test the pressure loss shall be determined in accordance with 5.3.2 with the sensor/thermowell fitted.

6.7 Manufacturing

The general requirements for the manufacturing of a gas meter are given in Annex D.

The manufacturer shall state the selected materials standards in the relevant documentation (see Clause 10).

Fabrication welds in any of the pressure containing parts shall be made using qualified welding procedures including heat treatments, by qualified welders or welding operators according to EN ISO 15607:2003,EN ISO 15609-1:2004, EN ISO 15614-1:2004 and EN ISO 15614-2:2005, EN ISO 9606-1:2013, EN ISO 9606-2:2004, ISO 17663:2009 and EN ISO 14732:2013 respectively.

In addition, for fabrication welds to make the meter body only full penetration welds shall be used.

This additional requirement is not applicable to seal welding.

For all pressure containing parts, the meter manufacturer shall establish and maintain suitable procedures to identify the material throughout the production from the receipt up to the final manufacturer’s test by markings or labelling or other equivalent methods.

7 Meter output (conformity)

7.1 Index

7.1.1 General

The meters, covered by this standard, shall include an integral, non-resettable and non-volatile means (index) of recording the volume of gas measured.

The index shall indicate the volume of the measured gas in cubic metres at metering conditions.

The unit m^3 shall be marked on the index plate.

The index shall not add positive values in case of reverse flow.

The index and its drive shall be sealed, or be capable of being sealed, in such a way that unauthorized intervention is not possible without breaking the seal.

The number of digits in the counter shall be such that it can show, to within one unit of the last digit, a volume of not less than 8000 h at Q_{max}.

The index, with the index housing, can be arranged to rotate to improve the ergonomics when the meter is fitted in the vertical or horizontal plane. If the index is of the rotatable type, the rotation shall not exceed 359°.

7.1.2 Magnetic coupling

7.1.2.1 Requirements

When tested in accordance with 7.1.2.2, a magnetic coupling, when used, shall transmit and maintain drive continuity of rotation between the meter measuring element and the index.

The torque transmission of any magnetic coupling shall be equal to at least three times that to which the drive can be subjected, including all indicating devices, output shafts and accessories designed for simultaneous operation by the magnetic drive unit as stated by the manufacturer.

7.1.2.2 Test

The magnetic coupling is fitted with all the devices designed for simultaneous operation and subjected to the maximum stated torque's where applicable (i.e. output shafts). The magnetic coupling is then operated to record an equivalent volume of gas to that passing through the meter during the endurance test, see 8.2.

Where employed, any mechanical indicating device is now to be set so that all the drums are reading 9.

The maximum torque required to operate devices and simultaneously rotate the drums of the indicating devices, where fitted, to zero, are measured and compared against the available torque of the magnetic coupling.

7.1.3 Mechanical indicating device

7.1.3.1 Requirement

When tested in accordance with 7.1.3.2, a mechanical indicating device shall consist of drums. These drums shall have a minimum diameter of 16 mm and shall be marked with the numerals 0 to 9, which shall have a minimum height of 4 mm.

Where the indicating device includes drums showing decimal sub-multiples of the cubic metre, these drums shall be separated by a clear decimal sign from those showing cubic metres. The decimal sub-multiples after the decimal sign shall be clearly distinguished from those in front of it.

Where the last numeral indicates a decimal multiple of the cubic metre the index plate shall bear:

a) either one (or two, or three, etc.) fixed zero(s) after the last numeral, or

b) the marking: x 10 (or x 100, or x 1 000, etc.) so that the reading is always in cubic metre.

The advance by one unit of a figure to any other shall take place completely while the figure of an order immediately below passes through the last tenth of its revolution.

7.1.3.2 Test

By visual inspection.

7.1.4 Test element

7.1.4.1 General

The meter shall be constructed either with an integral test element, or with arrangements permitting the connection to an external test unit.

The test element shall enable a resolution of 1/10 of the maximum permissible error of indication, with the meter running at Q_{min} for not greater than 30 min.

7.1.4.2 Test element of a mechanical indicating device

The integral test element can consist of the last continuously moving drum of the mechanical indicating device. This drum shall bear a scale, of which the spacing is not less than 1 mm and is constant throughout the whole scale.

The scale interval shall be in the form 1×10^n, 2×10^n, or 5×10^n m^3 (n being a positive or negative whole number or zero).

The scale marks shall be fine and uniformly drawn.

In the case where the scale interval is in the form 1×10^n, or 2×10^n m^3 all the lines representing multiples of 5, and where the scale interval is in the form 5×10^n m^3 all the lines representing multiples of 2, shall be distinguished by being longer than the other lines.

The scale marks shall be sufficiently fine to permit accurate and easy reading.

The test element can be provided with a scale mark which stands out in contrast to the scale and is of sufficient size to allow automatic photoelectric scanning. This scale mark shall not obscure the graduation and its presence shall not be detrimental to the accuracy of reading.

7.1.4.3 Pulse generator used as test element

A pulse generator can be used as a test element if it complies with the requirements of 7.4.

7.2 Index window

7.2.1 Requirements

7.2.1.1 General

Under normal condition of use, and for the normal life of the meter, when tested in accordance with 7.2.2.1, it shall be possible to read the index easily through the index window, whatever material is used for its construction.

The portion through which the index is viewed shall be transparent and cause no visual distortion of the subject to be viewed within an angle of 15° from normal to the window.

These tests shall be undertaken with the index window mounted on the index (totalizer) or on a meter.

7.2.1.2 Stiffness

When tested in accordance with 7.2.2.2, the index window shall break before interfering with the index wheels or gears, otherwise permanent signs shall remain on the window.

7.2.1.3 Ultraviolet radiation

When tested in accordance with 7.2.2.3, the index through the window of the indicating device and the name plate shall be clearly viewable.

Unless it is clear from the construction or from the indication on the meter that the indicating devices and data plates are not subject to direct radiation of the sun, those indicating devices and data plates shall undergo the test in 7.2.2.3.

7.2.1.4 Window impact

When tested in accordance with 7.2.2.4, the window shall remain intact and the index readable.

7.2.2 Tests

7.2.2.1 General

By visual inspection

7.2.2.2 Stiffness

Subject a force perpendicular to the plane of the window, applied by means of a 10 mm diameter wooden rod until the window breaks.

7.2.2.3 Ultraviolet radiation test

Confirm whether the test needs to be undertaken.

Expose the window of the indicating device and the name plate to the effects of ultraviolet radiation for five periods, each of 8 hours duration, using a suspended sun lamp which has been used not more than 400 h with a light source which has the same radiation spectrum as a Xenon lamp with a low transmission below 290 nm.

The test equipment needs to provide an energy of at least 765 $W \cdot m^{-2}$ over the entire surface of the tested items.

Ensure the surrounding air is not confined and free to circulate and regulated at (43 ± 3) °C.

After each exposure except the last, immerse completely the items in distilled water for 16 h and then clean and dry with cotton wool.

7.2.2.4 Window impact

Fit the window to the meter as in operation. Bring the temperature around the meter index to –5 °C., Drop a 25 mm solid steel ball three times, from a height of 250 mm, striking the centre of the window and falling normal to its plane.

7.3 Output drive shafts

7.3.1 Requirements

Meters can be fitted with output shafts to drive removable accessories, when they are fitted they shall meet the following requirements.

a) When tested in accordance with 7.3.2 a), the torque which the meters are required to produce in order to drive the additional devices fitted shall not produce any changes in the meter indication greater than the values specified in Table 8 and stay within the MPE.

Table 8 —Output shaft permissible errors

Value of Q_{min}	**Permissible change of the error of indication at Q_{min}**
< 0,05 Q_{max}	1 %
= 0,05 Q_{max}	0,5 %

b) When tested in accordance with 7.3.2 b), the mechanical drive couplings on the output shafts shall comply with the dimensions given in Figure 3.

Dimensions in millimetres

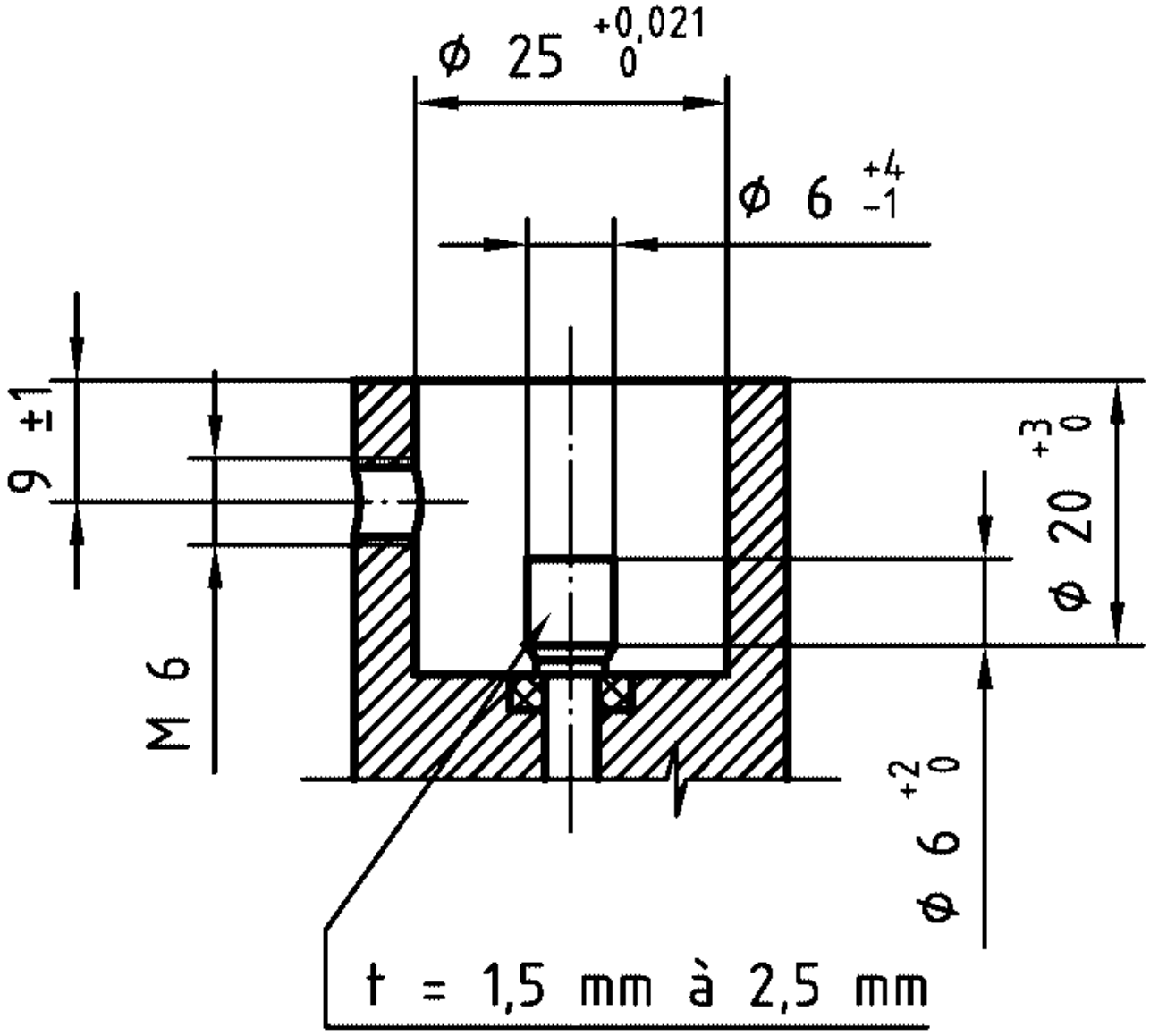


Figure 3 —Output shaft coupling

c) When tested in accordance with 7.3.2 c), the mechanical shaft shall be characterized by the indication of:

— its constant (C) in the form 1 tr ≙ … m^3 (or dm^3),

where:

tr equals one revolution

— the maximum permissible torque in the form M_{max} = ... N mm,

— the direction of rotation.

d) When tested in accordance with 7.3.2 d), when not connected, the exposed ends of the drive shafts shall be suitably protected, and capable of being sealed.

e) When tested in accordance with 7.3.2 a), the connection between the measuring device and the intermediate gearing shall not be broken or altered if a torque of three times the permissible torque as indicated in 7.3.1.a) is applied.

7.3.2 Tests

a) Apply the maximum torque as indicated on the meter to the drive shafts, or any other devices fitted. Run the meter at Q_{min} with air of density 1,2 kg m-^{3}. Measure the error of indication of the meter.

At least three meters of each size shall be tested with air at a density of 1,2 kg m-^{3} for compliance with the requirements of 7.3.1 a) and Table 8.

NOTE size is related to the design and capacity of the meter

When the type pattern approval embraces meters of various sizes, the torque test need only to be carried out on the meters of the smallest size, provided that the same torque is specified for the larger meters and that the shafts of the latter have the same or greater output constants.

For meters with several values of Q_{min}, the test is made at the lowest value. The permissible torque values for the other working ranges may be calculated from this test result. Conversion to other Q_{min} values is governed by the following rules:

1) where the flow is constant, the variation in error is proportional to the torque;

2) where the torque is constant, the variation in the error is inversely proportional to the flow rate ratio.

b) By inspection

c) By visual inspection

d) By visual inspection

Apply the torque to a value of three times the maximum permissible torque on the shaft and inspect it.

7.4 Pulse generators

7.4.1 General

Meters can include devices which are capable of generating an electronic signal that is proportional to a specific volume of gas.

These devices are called pulse generators for the purpose of this standard and can be in the form of:

— voltage free contacts;

— proximity switch devices;

— solid state devices;

— other devices.

Pulse generators can be fitted to a meter, as an integral part of the meter, or as an attachment, or a combination thereof.

Pulse values shall be expressed in the form of 1imp equivalent to…m^3 or 1m^3 equivalent to …imp and shall be inscribed on a data plate adjacent to the output connection.

The pulse value shall be calculated, with not less than six significant digits, from the ratio between volume indicated on the meter and the number of pulses generated when the volume was measured.

The manufacturer shall provide documentation from which the calculation of the pulse value can be verified. The calculated pulse value as specified, shall be capable of being verified with an uncertainty not greater than 0,05 %.

The use of a pulse generator shall allow appropriate safe operation in accordance with the requirements of EN 50014 and EN 50020.

The components of the pulse generator shall provide a minimum of 1 year of operation at Q_{max}.

Pulse generators shall be in accordance with EN 61000-6 to fulfil the electromagnetic compatibility requirement for the level indicated by the manufacturer.

All pulse generators shall be provided with the means of plugging and sealing against unauthorized interference.

7.4.2 Specification for low frequency pulse generator

A meter can be fitted with a pulse generator providing integer number of pulses per 10^n m^3 (n being a positive or negative integer number or zero).

The values of the pulse shall be in accordance with Table 9.

Table 9 — LF pulse values

Q_{max}	pulse value
25 to 100	1 imp ≙ 0,1 m^3 or 1 imp ≙ 0,01 m^3
160 to1 000	1 imp ≙ 1 m^3 or 1 imp ≙ 0,1 m^3
> 1 000	1 imp ≙ 10 m^3 or 1 imp ≙ 1 m^3

The open and close times shall be greater than 200 ms.

7.4.3 Specification for high frequency pulse generator

When the meter is fitted with a high frequency output, the signal at Q_{max} shall be in the range 0,05 kHz to 5 kHz.

7.4.4 Electrical Connection

The connection shall have a minimum protection class of IP 65 (EN 60529) and shall be capable of being fitted with electrically shielded wiring. All socket connections shall have a retained protection cap.

All pulse generators shall be provided with the means of plugging and sealing against unauthorized interference.

8 Durability (conformity)

8.1 Requirements

When tested in accordance with 8.2, meters shall retain their metrological characteristics, within the defined limits, over their expected life. Meters, prior to undergoing the durability test shall meet the following requirements:

a) the error of indication shall be within the initial maximum permissible errors given in Table 2 when tested in accordance with 5.2.2 a;

b) the pressure loss shall be as specified in 5.3.

On completion of the durability test all meters shall meet the following requirements: the difference in errors of indication, at all tested flow rates, between the start and the end of the test shall be less than 1/3 of the maximum permissible errors, given in Table 2 providing that the test is carried out in accordance with 5.2.2 a.

8.2 Tests

One meter of a size representative of a meter family shall be subjected to the test for pattern approval.

The test is to be carried out at the Q_{max} capacity of the meter. After having measured a volume of gas or air having a density not less than 1,2 kg.m^{-3}, equivalent to 1 000 h at this capacity, the meter error of indication shall be re-determined.

At the end of the durability test the error of indication shall be measured under the same conditions and with the same test facilities used at the beginning of the test.

The durability test shall be completed within an eight week period.

Meters subjected to the durability test shall be fitted with their indexes.

9 Marking, labelling and packaging (conformity/individual)

9.1 General

Each meter shall bear, in a group, either on the face plate, or on a special data plate, the following markings:

a) The type of the meter and the number of the EC type or design examination certificate;

b) the number of this European Standard: EN 12480:2015;

c) the manufacturer's trade mark or his trade name and where appropriate, their authorized representative established within the European Union;

d) Manufacturers clear identification as name and address or logo;

e) the serial number of the meter and its year of manufacture;

f) accuracy class: AC 1,0

g) maximum flow rate: Q_{max} = …m^3/h and the minimum flow rate: Q_{min} = …m^3/h;

h) the operating pressure range: P = ... to …MPa (or kPa, or Pa, or bar);

i) the maximum allowable pressure: PS = … MPa (or kPa, or Pa, or bar);

j) The design temperature range: TS = … to … °C

k) The volume V of the meter: V = … L

l) the nominal value of the cyclic volume: *Vcyc* = ... dm^3 ;

m) operating temperature range: *t* = … to … °C

n) storage temperature range ts = …to ... °C; (Optional: could be in the manual only)

o) the volume per pulse output;

p) if required, a commercial designation of the meter, a special serial number, the name of the gas distributor, the name of the repairer and the year of repairing.

Other markings can be labelled under special request.

9.2 Direction of flow

The direction of the flow shall be clearly and permanently marked on the meter.

9.3 Pressure tappings

The pressure tappings for the metering pressure shall be clearly and indelibly marked with the symbol p_m; the other pressure tapping with the symbol *p*.

9.4 Durability and legibility of marking

9.4.1 Requirements

Any marking and data plate, not forming part of a meter index plate under official seal, shall be permanently fixed to the meter, directly visible, easily legible and indelible under normal conditions of use of the meter, and when subjected to the test given in 9.4.2.

The index and the index plate, when viewed through the index window, shall remain legible after being subjected to the test given in 7.2.2.

Compliance is checked by visual inspection.

9.4.2 Test

All markings on the external surface of the meter, which can be touched when the meter is in normal use, are subjected to the indelibility test as specified in EN 60730-1:2000, Annex A.

10 Documentation (conformity)

10.1 General

On the request of the customer the following information shall be provided with each meter or group of meters used in the same location.

10.2 Documentation related to the manufacturer's tests

Inspection certificate and/or material certificate shall be in accordance with EN 10204:2004.

Calibration certificate(s).

Pressure test certificate(s).

10.3 Declaration of conformity

The manufacturer shall provide a declaration of conformity to this harmonized Standard and all relevant Directives.

10.4 Instruction manual

The operating instructions shall be available in written form or electronic format and shall identify the name and address of the manufacturer and the date of issue.

Each meter, or group of meters, shall be delivered with the installation, operation and maintenance manuals, in a language acceptable by the user and easily understandable, giving appropriate information on:

— safe use;

— gas family;

— rated operating conditions;

— climatic class;

— power supply;

— Installation conditions;

EXAMPLE position, closed or open locations, condensing or with non-condensing humidity

— mechanical and electromagnetic environment classes;

— additional precautions to cover the risk of traffic, wind, earthquake loading and external fire;

— safety requirements concerning commissioning and de-commissioning procedures;

— safety requirements on filling/discharge of gas of/from the meter;

— statement if a maintenance is possible and a relevant instruction;

— hazards arising from misuse and particular features of the design when appropriate;

— way of controlling the proper installation and functioning;

— conditions for compatibility with interfaces;

— provisions, if any, for transport and handling;

— how to trace the right spare parts;

— storage requirements for spare parts if relevant;

— avoidance of possible problems arising from the dynamic behaviour of the meter and installation.

Annex A
(normative)

Pattern approval

Table A.1 – Pattern approval

Chapter	Requirements	Pattern approval		Clause
		examination	Test	
4	Operating range			
	Flow rate range	x		4.2
	Operating pressure range	x		4.3
	Operating temperature range	x		4.4
5	Metrological performance			
	Error of indication		x	5.2
	Pressure loss		x	5.3
	Metrological repeatability		x	5.4
	Operating pressure		x	5.5
	Temperature ranges		x	5.6
	Condensing ambient condition		x	5.7
	Bi-directional meter		x	5.8
	Influence of oil filling		x	5.9
6	Design and manufacturing			
	Tampering	x		6.1
	Material	x	x	6.2
	Protection against gas	x		6.2.1
	Resistance to external corrosion		x	6.2.3
	Penetration resistance		x	6.2.4.
	Adhesion of the protective coating		x	6.2.5
	Materials for pressurized parts		x	6.2.6
	Resistance to internal pressure		x	6.3.1
	Resistance to high temperature	x	x	6.3.2

	External leak tightness	x	x	6.3.3
	Overload		x	6.3.4
	Bending and torsional moment		x	6.3.5
	Transportation and storage	x	x	6.4
	Connections	x		6.5
	Pressure tappings	x		6.6.1
	Temperature tappings	x		6.6.2
7	Meter output			
	Index	x	x	7.1.1; 7.1.2
	Mechanical indicating device		x	7.1.3
	Test element of a mechanical indicating device	x		7.1.4.2
	Pulse generator used as test element	x		7.1.4.3
	Index window – Visual	x	x	7.2.1.1
	Index window – Stiffness	x	x	7.2.1.2
	Index window – UV radiation test		x	7.2.1.3
	Index window – Impact		x	7.2.1.4
	Output drive shafts		x	7.3
	Pulse generator	x		7.4
8	Durability		x	8.1
9	Marking	x		9
	Durability and legibility of marking		x	9.4
10	Documentation	x		10

NOTE Under the EU Directive 97/23/EC Annex I, the manufacturer is responsible for all aspects including design, manufacture inspection, and testing. “Conformity Assessment” by a Notified Body is prescribed in other annexes of the EU Directive 97/23/EC.

Annex B
(normative)

Individual meter testing

In order to ensure safety and metrological requirements of all meters produced, minimum individual testing shall be done according to Table B.1.

Table B.1 – Individual testing

Chapter	Requirements	Production Routine		Clause
		examination	Test	
5	Metrological performance			
	Error of indication		x	5.2
	Pressure loss		x	5.3
	Operating pressure		x[a]	5.5
6	Construction and material			
	Tampering	x [b]		6.1
	Resistance to internal pressure		x	6.3.1
	External leak tightness		x	6.3.3
	Transportation and storage	x		6.4
7	Pulse generators	x		7.4
9	Marking	x		9
10	Documentation	x		10
[a] when applicable [b] examination of seals				

NOTE Under the EU Directive 97/23/EC Annex I, the manufacturer is responsible for all aspects including design, manufacture inspection, and testing. “Conformity Assessment” by a Notified Body is prescribed in other annexes of the EU Directive 97/23/EC.

Annex C
(normative)

Resistance to high temperature (optional)

If the manufacturer declares the meter resistant to high temperatures the meter shall comply with this annex.

C.1 Requirements

When tested according to the procedure specified in C.2 the leakage value of the meter casing shall not exceed the limits stated in Table C.1.

Table C.1 – High temperature tests

	$Q_{max} \leq$ 40 m^3/h	$Q_{max} >$ 40 m^3/h
Max. admissible leakage rate[a]	0,150 m^3/h	0,450 m^3/h
Test temperature	650 °C	650 °C
Steady-state period of time	30 min	30 min
Test medium	nitrogen	nitrogen
Test pressure[b]	max. pressure	max. pressure

[a] Concerning the leakage rates it is the gas outlet rate, converted to the normal condition: 0 °C and 1 013,25 mbar (1,013 25 bar)

[b] The test pressure can be selected according to the range of application (e.g. residential area) depending on the occurring maximum operation pressures.

C.2 Test

C.2.1 Apparatus

The furnace shall be capable of allowing an ambient temperature rise according to the curve defined in ISO 834-1. The dimension of the furnace shall allow the installation of the meter under test and its connections to be in positions similar to those used in practice. Arrangements are to be provided to maintain a constant pressure within the meter casing.

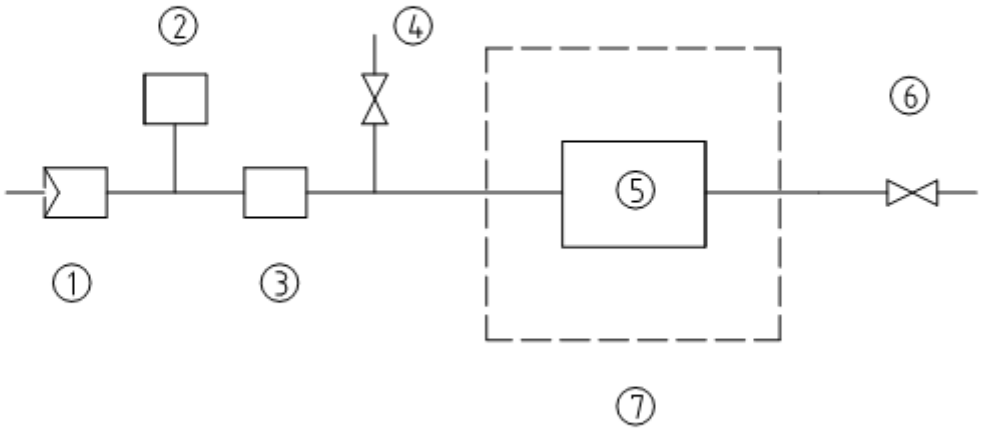
C.2.2 Test conditions

- temperature rises in the furnace according to the curve specified in ISO 834-1 up to the time when the coldest part of the meter reaches 650 °C ;
- constant temperature at this value for 30 min;
- test pressure: maximum 5 bar;
- test gas nitrogen

C.2.3 Test procedure

The test may be carried out on an empty case.

Connect the meter (the meter casing) under test to the inlet and outlet connections and install the assembly in the centre of the furnace, using supports if necessary:



Key

1	Pressure regulator
2	Manometer
3	Check meter
4	Bleed valve
5	Meter at centre of furnace
6	Purge valve
7	Furnace

Figure C.1 — Apparatus of a high temperature testing (system of the apparatus)

With the bleed valve closed, pressurize the meter with nitrogen to the test pressure and verify its tightness.

With the meter at the test pressure, increase the temperature of the furnace according to the temperature rise curve of ISO 834-1.

When the temperature at the coldest point of the meter under test reaches 650 °C, control the furnace temperature to maintain at that point a constant temperature of 650 °C for a period of 30 min.

During the complete test maintain the pressure in the meter under test at the test pressure, e.g. by means of a bleed valve. The leakage rate is registered by successive metering; the metering periods are not to exceed 5 min.

The leakage is the quotient of the metered nitrogen volume by the measuring time.

C.3 Marking

For identification that the meter meets the requirements of C.1, the test pressure is marked on the plate of the meter according to Clause 9 as follows:

$$\mathrm{HTR}p_{\max} = \ldots \mathrm{MPa}\ \left(\mathrm{kPa, Pa, bar}\right)$$

Annex D
(normative)

Compliance evaluation for gas meters

D.1 General

Manufacturers shall have procedures to ensure the final product when placed on the market is fit for purpose and will perform satisfactorily over its life.

D.2 Quality Management System

D.2.1 General

An organization producing meters to comply with this European Standard shall operate a Quality Management System.

For meters certified in compliance with this document, the manufacturer shall carry out the compliance evaluation in accordance with D.2.3

D.2.2 Procedures

As part of the Quality Management System the organization shall provide and maintain suitable manufacturing procedures to ensure that components and meters comply with the design.

In particular these procedures shall ensure that:

— preparation of component parts do not give rise to defects or cracks or changes in mechanical characteristics likely to be detrimental to the safety of the meters.

— pressure joints and adjacent zones are free of any surface or internal defects detrimental to the safety of the equipment.

— The properties of permanent joints meet the minimum provisions specified for the materials to be joined unless other relevant property values are specifically taken into account in the design calculations.

— Permanent jointing of components which contribute to the pressure resistance of the complete meters is carried out by suitably qualified personnel according to suitable operating procedures.

— non-destructive tests of permanent joints are carried out by suitably qualified personnel who shall be approved by a third party organization for meters in categories III and IV.

— suitable heat treatment is carried out at appropriate stages of manufacture where there is a risk that the manufacturing process will change the material properties to an extent which would impair the safety of the meter.

— materials making up the components of the meter which contribute to pressure resistance are traceable through receipt, production up to the final test.

D.2.3 Manufacturer's compliance evaluation

Individual production meters shall be subjected to final assessment, which shall include a visual examination of the meter and accompanying documents to ensure compliance with this standard, e.g. appropriate test certificates.

For each series of meters the manufacturer shall carry out:

— the tests as detailed in Annex B;

— a permanent internal control of production using a quality management system

Furthermore, the manufacturer shall retain and file which includes:

— the material certificates for all pressure containing parts;

— the NDT reports and the inspection certificate;

for a period of at least 10 years from the delivery of the meter.

A copy of these certificates shall be made available to the purchaser if requested in the order specification.

D.2.4 Issue of the certificate of compliance

If the series of meters complies with this document a "certificate of compliance" shall be issued.

Annex E
(normative)

Non-destructive testing (NDT)

Meter bodies which are non-destructively tested shall be in accordance with this annex.

Table E.1 — Non-destructive testing

<table>
<tr><td colspan="2" rowspan="3"></td><td colspan="6">Type of non-destructive testing</td></tr>
<tr><td colspan="2">Volumetric</td><td colspan="3">Surface</td></tr>
<tr><td>Radiographic</td><td>Ultrasonic</td><td>Visual</td><td>Magnetic particle</td><td>Liquid penetrant</td></tr>
<tr><td rowspan="3">Sections to be examined and/or extent of coverage</td><td>Steel Castings</td><td colspan="2">EN 12516–1:2014,10.3.2</td><td>Accessible surfaces</td><td colspan="2" rowspan="2">EN 12516–1:2014,10.3.3</td></tr>
<tr><td>Forgings, bars, plates and tubular products</td><td colspan="2">EN 12516–1:2014,10.4 and 10.5</td><td>Not applicable</td></tr>
<tr><td>Welded Fabrication welds</td><td colspan="2">According to E and F in Table E.2</td><td>Accessible surfaces</td><td colspan="2">According to B in Table E.2</td></tr>
<tr><td colspan="2">NDT procedures and acceptance criteria for castings, forgings and their fusion weld repairs</td><td>EN 12516–1:2014, Annex B</td><td>EN 12516–1:2014, Annex E</td><td>EN ISO 17637</td><td>EN 12516–1:2014, Annex C</td><td>EN 12516–1:2014, Annex D</td></tr>
<tr><td colspan="2">NDT procedures and acceptance criteria for fabrication welds, including their repairs</td><td>Class B into EN ISO 17636, acceptance level 2 into EN ISO 10675-1</td><td>EN ISO 23279, examination level B into EN ISO 17640 acceptance level 2 into EN ISO 11666</td><td>EN ISO 17637</td><td></td><td></td></tr>
</table>

General requirements	— Examinations shall be performed on the material after any heat treatment required by the material or welding procedure specification, either before or after the finish machining at the option of the manufacturer. — Accessible surfaces in case of surface examination include exterior and interior surfaces but no threads, drilled or threaded holes etc. — Volumetric examination on castings and full penetration butt welds up to 60 mm thickness shall be done radiographically and ultrasonically on forgings and other (full penetration) welds, however one of these techniques they may be substituted by each may substitute the other, provided that the purchaser agrees and it can be demonstrated that interpretable results are produced.

Table E.2— Minimum inspection sample

	p_{max}	DN				
		< 100	≥ 100 < 150	≥ 150 < 200	≥ 200 < 250	≥ 250
Castings	≥ 100	A + B	A + C	A + C	A + D	
	50 ≤ p_{max} < 100		A + B			
	< 50	A				
Forgings, bars, plates and tubular products	≥ 100	/		C	C	D
	50 ≤ p_{max} < 100			/		
Full penetration fabrication Welds	> 16	A + F1)				
	5 < p_{max} ≤ 16	A + E 1)				

A is the Visual examination on 100 % of the production batch.

B is the Magnetic particle or liquid penetrant examination on 100 % of the production batch.

C is the Volumetric examination on a random 10 % of the production batch at random.

D is the Volumetric examination on a random 20 % of the production batch at random.

E is the Volumetric examination on a random 10 % of the circumferential, corner and nozzle seams at random of the production batch and 100 % of the longitudinal seams offrom the production batch.

F is the Volumetric examination on a random 20 % of the circumferential, corner and nozzle seams at random of the production batch and 100 % of the longitudinal seams offrom the production batch.

NOTE A production batch consists of castings or forgings from the same melt and the same heat treatment or welds made by the same process and/or welder or welding operator. An inspection sample is a percentage of the aforementioned production batch.

1) Welded joint coefficient in respect of values given in 6.2.6.3.5

In the case of random inspection, if a casting, forging or weld does not conform to the acceptance criteria, a further inspection sample of twice the original sample size from the production batch shall be examined. If one of these castings, forgings or welds fails, the examination shall be extended to all castings, forgings or welds in the production batch.

Any casting, forging or weld that does not conform to the acceptance criteria shall be repaired according to an applicable procedure and then re-examined.

The NDTs shall be carried out by qualified personnel in accordance with EN ISO 9712:2012.

Annex F
(normative)

Materials for pressurized parts

Table F.1 — List of materials covered by harmonized supporting standards to PED

The steel materials listed in Table F.1 with the restrictions listed in the last 5 columns of the same table, are suitable for the design of pressure containing parts of meters complying with this European Standard.

Materials			Restrictions				
Group	Type	Relevant standard	Meter body				
			Operating temperature		PS_{max}	$[PS \times DN]_{max}$	DN_{max}
			−10 °C to 60 °C a	−20 °C to 60 °C	bar	bar x mm	mm
Pressure containing parts							
Rolled and forged steel	P235GH / 1.0345, P265GH / 1.0425, P295GH/ 1.0481, P355GH / 1.0473 all with thickness ≤ 150 mm	EN 10028–2:2009	x		100		
	P275NH / 1.0487, P355NH / 1.0565 with thickness ≤ 150 mm, P355NL1 / 1.0566 with thickness ≤ 150 mm	EN 10028–3:2009		x			
	All types	EN 10028–4:2009, EN 10028–5:2009		x			
	All grades from P355. to P 500… with thickness ≤ 150 mm	EN 10028–6:2009		x			
	All steel designation with Amin ≥ 16 %	EN 10028–7:2007		x			

	All steel designations with Amin ≥ 16 % and at –20 °C KV 27 J av. of three and 20 J min		EN 10222–1:1998					
	All steel designations martensitic type		EN 10222–5:1999	x				
	All steel designations austenitic type				x			
	All steel designations with Amin ≥ 16 %, and at –20 °C KV 27 J av. of three and 20 J min		EN 10272:2007		x			
Cast Steel	All steel designations		EN 10213:2007		x			

Table F.2 — List of materials not based on harmonized standards but inherently meeting PED

Materials				Restrictions				
Group	Type		Relevant standard	Meter body				
				Operating temperature		PSmax	[PS x DN]max	DNmax
				-10 °C to 60 °C a	-20 °C to 60 °C	bar	bar x mm	mm
Pressure containing parts								
	S235JR / 1.0037 with thickness ≤ 40 mm, S275JR / 1.0044 with thickness ≥ 1,5 mm, S355JR/ 1.0045 with thickness ≥ 1,5 mm		EN 10025	x				
	S235J2G3 / 1.0116 and S235J2G4 / 1.0117 both with nominal thickness ≤ 150 mm, S275J2G3 / 1.0144 and S275J2G4 / 1.0145 and S355J2G3 / 1.0570 all with 1,5 mm < nominal thickness ≤ 150 mm		EN 10025		x			
	S275JO / 1.0143 and S355JO / 1.0553 both with 1,5 mm < nominal thickness ≤ 250 mm and at –20 °C KV 27 J av. of three and 20 J min		EN 10025		x			

Rolled and forged steel	25 CrMo4 / 1.7218 and 25CrMoS4 / 1.7213 both with 100 mm < d ≤ 160 mm or 60 mm < t ≤ 100 mm, 36CrNiMo4 / 1.6511 with Amin = 16 %. All types shall be quenched and tempered (+QT) and with cast analysis C ≤ 0.25 % or, when 0.25 % < C ≤ 0.40, Ni ≥ 1 %.	EN	EN 10083–1:2006	x		100	–	
	36CrNiMo4 / 1.6511 quenched and tempered (+QT)with Amin = 16 % and KV 27 J av. of three and 20 J min. at –20 °C..				x			
	All steel designations quenched and tempered (+QT) with Amin ≥ 16 % and with cast analysis C ≤ 0.25 %.		EN 10083–2:2006	x				
	11SMn30 / 1.0715, 11SMn37 / 1.0736, 11SMnPb30 / 1.0718, 11SMnPb37 / 1.0737 all with 16 ≤ d ≤ 100 and Amin 16 %		EN 10277–3:2008	x				25
	As above and types 35S20 / 1.0726, 35SPb20 / 1.0756, 36SMn14 / 1.0764, 36SMnPb14 / 1.0765, 38SMn28 / 1.0760, 38SMnPb28 / 10761, 44SMn28 / 1.0762, 44SMnPb28 / 1.0763, 46SPb20 / 1.0757 with KV 27 J av. of three and 20 J min at –20 °C				x			

	All austenitic steel designations with longitudinal Amin ≥ 16 % and other steel designations with longitudinal Amin ≥ 16 % and KV 27 J av. of three and 20 J min. at –20 °C		EN 10088–3:2014		x			–
	DD11 / 1.0332, DD12 /1.0398, DD13 / 1.0335		EN 10111: 2008	x				
	All steel designations used for skin-pass		EN 10130: 2006	x				
	All steel designations with Amin ≥ 16 % and at –20 °C KV 27 J av. of three and 20 J min		EN 10250–1:1999		x			
	All steel designations with cast analysis C ≤ 0,25 % and with longitudinal Amin ≥ 16 %		EN 10250–2:1999	x				
	S235J2G3 / 1.0116, S355J2G3 / 1.0570 with tR ≤ 500 mm				x			
	All steel designations with Amin ≥ 16 % except X30Cr13 / 1.4028		EN 10250–4:1999	x				
	All austenitic grades				x			

Spheroidal graphite cast iron	EN-GJS400–18 / EN-JS1020, EN-GJS400–18-LT / EN-JS1025, EN-GJS400–15 / EN-JS1030, EN-GJS 400–18U-LT / EN-JS1049	EN 1563:2011			x	20	1500	1000
	A 395M	ASTM	A 395/A 395M: 2009		x			
	A 536 Grades 60–40–18 and 65–45–12		A 536: 2009		x			
	A 874M		A 874/A 874M: 2009		x			
	400–18, 500–7	ISO 1083:2004			x			
	EN-GJS400–18-LT / EN-JS1025, EN-GJS-400–18U-LT / EN-JS1049 with wall thickness ≤ 60 mm	EN 1563:2011			x	50	5000	300
	EN-GJS400–15 / EN-JS1030, EN-GJS-400–18U-RT / EN-JS1059 with wall thickness ≤ 60 mm			x				
	400–18L	ISO 1083:2004			x			
	400–18			x				
	A 395M	ASTM A395/A 395M: 2009		x				
	A 536 Grade 60–40–18	ASTM A 536: 2009		x				
Copper-zinc wrought alloys	All material designations with A ≥ 15 %	EN	EN 1652:1997		x	100	–	25
	All material designations with A ≥ 15 %		EN 12164:2011		x			
	All material designations with A ≥ 15 %		EN 12165:2011		x			
Copper-tin and copper-zinc cast alloys	Cu Sn5Zn5Pb5-B (CB491K) and CuSn5Zn5Pb5-C (CC491K)	EN 1982:2008			x	20	1000	100

Aluminium wrought alloys	All metallurgic state and thickness for which Amin ≥ 4 %		EN 485–2:2013		x	20	–	150
	All metallurgic state and dimensions for which Amin ≥ 4 %		EN 586–2:1994		x			
			EN 754–2:2013		x			
	All metallurgic state and thickness for which Amin ≥ 4 %		EN 755–2:2013		x			
Aluminium wrought alloys	All metallurgic state and thickness for which Amin ≥ 7 %	EN	EN 485–2:2013		x	50	–	50
	All metallurgic state and dimensions for which Amin ≥ 7 %		EN 586–2:1994		x			
			EN 754–2:2013		x			
	All metallurgic state and thickness for which Amin ≥ 7 %		EN 755–2:2013		x			
	All metallurgic state and thickness for which Amin ≥ 7 %		EN 485–2:2013		x	100	–	25
	All metallurgic state and dimensions for which Amin ≥ 7 %		EN 586–2:1994		x			
			EN 754–2:2013		x			
	All metallurgic state and dimensions for which Amin ≥ 7 %		EN 755–2:2013		x			

Aluminium cast alloys	All alloy designations with elongation ≥ 1,5 %		EN 1706:2010		x	10	250	150
	All alloy designations with elongation ≥ 1,5		ASTM B 85/B 85M: 2010		x			
	All alloy designations with elongation ≥ 2 %		EN 1706:2010		x	20	3000	150
	All alloy designations with elongation ≥ 4 %		EN 1706:2010		x	20	3000	1000
	All alloy designations with elongation ≥ 4 %		ASTM B 85/B 85M: 2010		x			
Pipes	Cu 999		EN 1057:2006+A 1:2010		x	25	–	–
	X6CrNiMoTi17–12–2 / 1.4571		EN 10088–1:2014		x	100	–	–
	All grades		A 106/A 106M: 2011		x			
	TP 304, TP 304L, TP 316, TP 316L	ASTM	A 213/A 213M: 2011		x			
	TP 304, TP 304L, TP 316, TP 316L		A 269: 2010		x			
	TP 304		A 312/A 312M: 2012		x			
	Grade 6		A 333/A 333M: 2011		x			

Compression fittings	All steel designations in Table 5, 11SMn30 / 1.0715 with Amin 8 % and 10 ≤ d ≤ 16, 11SMnPb30 / 1.0718 and 11SMnPb37 / 1.0737 both with Amin 8 % and 5 ≤ d ≤ 100	EN	EN 10087:1998		x	100	–	–
	All steel designations		EN 10088–3:2014		x			
	All steel designations		ISO 8434		x			
	All grades		ASTM A 420/A 420M: 2006		x			

Fasteners								
Bolts, screws, studs and nuts	Class 10.9	EN ISO 898-1:2013			x	50	–	–
	Class 10	EN ISO 898-2:2012			x			
	All alloy groups and types with Amin ≥ 9 % for bolts, screws and studs	ASTM F 593:2008			x			
	Class 4.6, 5.6, 8.8	EN	ISO 898-1:2013		x	100	–	–
	Grade A2ss, A4ss	EN	EN ISO 3506		x			
	Classes. 5, 8, 9 for nuts	EN	EN ISO 898-2:2012		x			
	All grades	ASTM	A 193/A 193M: 2012		x			
	All grades for nuts	ASTM	A 194/A 194M: 2012		x			
	All classes and grades	ASTM	A 320/A 320M: 2011		x			
	All alloy groups and types with Amin ≥ 12 % for bolts, screws and studs	ASTM	F 593: 2008		x			
	All alloy groups	ASTM	F 594: 2009		x			

Table F.3 — List of materials based on other standards (non EN standards) that require supplementary specification to meet PED

Materials				Restrictions				
Group	Type	Relevant standard		Meter body				
				Operating temperature		PSmax	[PS x DN]max	DNmax
				-10 °C to 60 °C a	-20 °C to 60 °C	bar	bar x mm	mm
Pressure containing parts								
Rolled and forged steel	A 105M with chemical composition C ≤ 0,25 %, A 105N (normalized) with hardness between 137HB to 187HB (supplementary requirements S1 and S2.4)	ASTM	A 105/A105M: 2011	x		100	–	–
	A 106 grade A A 106 grade B with C ≤ 0,25 % or hardness ≤ 187 HB		A 106/A 106M: 2011	x				
	F304/F316/F5a/F6a class 2		A 182/A 182M: 2012		x			
	A 234M grades WPB, WPC and WP1 with chemical composition C ≤ 0,25 % and all remaining grades		A 234/A 234M: 2011	x				
	All austenitic types		A 240/A 240M: 2012		x			
	All martensitic and ferritic types with KV 27J av. of three and 20J min. at –20°C							
	A 266 grade 4 with chemical composition C ≤ 0,25 %		A 266A/ 266M: 2011	x				
	A 276 all austenitic grades		A 276: 2010		x			
	A 333M all grades		A 333/A 333M: 2011		x			

	A 350M LF2 class 1, LF3, LF5 classes 1 and 2, LF6 class 1 and 2, LF9, LF787 classes 2 and 3		A 350/A 350M: 2010		x			
	A 420M all grades		A 420/A 420M: 2006		x			
	A 513 all grades with Amin 16 % and with chemical composition C ≤ 0,25 %		A 513/A 513M: 2012	x				
	A 513 all grades normalized with Amin 16 % and at –20°C KV 27J av. of three and 20J min.				x			
	A 516 all grades with KV 27J av. of three and 20J min. at –20°C		A 516/A 516M: 2010		x			
	A 564 T630 H1150 with KV 27J av. of three and 20J min. at –20°C,		A 564/ 564M: 2010		x			
	A 694 all grades		A 694/ A694M: 2008	x				
	A 694 Gr F60 with KV 27 J av. of three and 20 J min at – 20 °C				x			
	A 707M all grades from L2 to L8 and all classes		A 707/A 707M: 2010		x			

Annex G
(normative)

Additional tests for meters to be used in open locations

G.1 General

Meters complying with this annex shall be marked in accordance with 9.1.

G.2 Weathering

G.2.1 Requirements

All markings on the meter, the index and index plate when viewed through the index window and any separate data plate, if fitted, shall remain easily legible after being subjected to the test given in **G.2.2**.

Total colour difference measured in accordance with ISO 7724-3:1984 shall be inside the following limits:

$\Delta L^* \leq 7$

$\Delta a^* \leq 7$

$\Delta b^* \leq 14$

Light transmission in accordance with ASTM D1003: shall have Haze [%] ≤ 15.

G.2.2 Test

One meter shall be exposed for 66 days to artificial weathering and exposure to artificial radiation in accordance with EN ISO 4892-3 and the parameters in Table D.1. Prior to exposure measurements will be made to enable the test criteria to be assessed.

Table G.1 – Weathering tests

Test cycle	Wavelength/lamp type	Irradiance	Black panel-temperature
8 h dry 4 h condensation	UVA 340	0,76 $W.m^{-2}$ nm^{-1} at 340 nm light out	(60 ± 3) °c (50 ± 3) °c

Following exposure the meter shall be visually inspected for legibility. All markings on the meter, the index and index plate when viewed through the index window and any separate data plate, if fitted, shall remain easily legible. Appropriate tests shall be carried out to check the requirements for colour difference and transmission of light are met.

Annex H
(normative)

Meter family

H.1 Definition of meter family

A meter family in respect to the pattern approval is a group of meters of different sizes but with similar construction. By specifying a meter family it is possible to reduce the number of tests and documents during assessment

The manufacturer shall make suggestions for grouping instruments to a family. The Test House assesses the suggestion and may modify or refuse the proposal.

H.2 Criteria for grouping meters together in order to form a family

The meters shall have the following characteristics:

— the same manufacturer;

— the same measuring principle;

— the same accuracy class;

— a similar construction and component assembly;

— the same materials for those components that are critical to the performance of the meter;

— the same rated operating conditions;

— roughly the same ratios Q_{max} / Q_{min} and Q_{max} / Q_t or, if not, the tests shall be carried out on the meter version which has the highest ratios;

— for TC-meters the same temperature compensating construction;

— the same versions of electronic devices for each meter size(these devices may be optional).

The meters within a family may have different display device versions as long as it is demonstrated by design argumentations or tests that they have the same influence on the metrological performances.

Every test shall be carried out for the meter version for which the highest dependency in respect to the influence value is expected.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/32 Measuring Instruments Directive

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2014/32 Measuring Instruments Directive.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA — Correspondence between this European Standard and Directive 2014/32 Measuring Instruments Directive

Clause(s)/sub-clause(s) of this standard	Essential Requirements (ERs) of Directive 2014/32	
	Nature of Essential requirement	item
		ANNEX I
	Allowable errors under rated operating conditions	**1**
4.2/ 5.2/ 5.4/ 6.3.4	Within MPE – no disturbance	1.1
4.3/ 4.4 5.5/ 5.6/ 5.7/ 5.8/ 5.9/ 7.3	Within MPE – disturbance	1.2
10	Specify climatic, mechanical and EM environment	1.3
4.4/ 5.6/ 5.7	Climatic environments	1.3 1
1./ 6.3.5/ 6.4	Mechanical environments	1.3.2
7.4.1	Electromagnetic environments	1.3.3
6.3.4/ 6.3.5/ 7.1.2	Other influence quantities	1.3.4
Covered by whole standard	Basic rules	1.4.1
6.2.3/ 7.4.4/ Annex G	Ambient humidity	1.4.2
N/A	**Reproducibility**	**2**
5.4	**Repeatability**	**3**
5.2 / 7.1.3/ 7.1.4	**Discrimination and sensitivity appropriate for measurement task**	**4**
8/ 10	**Sufficient durability for intended task (see….)**	**5**
Covered by whole standard	**Reliability**	**6**
	Suitability	**7**
6.1/ 7.2 / 7.4.1/ 7.4.4/ 9.2	Design discourages fraudulent use and minimizes unintentional misuse.	7.1

1/ 5.3/ 6.3.3/ 6.3.5/ 6.4/ 7	Designed to be suitable for its intended use and working conditions. User friendly.	7.2
N/A	The errors of a utility measuring instrument at flows or currents outside the controlled range shall not be unduly biased.	7.3
N/A	Where a measuring instrument is designed for the measurement of values of the measure and that are constant over time, the measuring instrument shall be insensitive to small fluctuations of the value of the measure and, or shall take appropriate action.	7.4
6.1 / 6.2 / 6.3	Robust and materials suitable for intended use	7.5
6.6/ 7/ 10	A measuring instrument shall be designed so as to allow the control of the measuring tasks after the instrument has been placed on the market and put into use.	7.6
	Protection Against Corruption	**8**
6.6/ 7.1.2/ 7.2 / 7.3 / 7.4	Measurement cannot be affected by feature of instrument, connection of external or communicating device.	8.1
6.1/ 7.2	Critical hardware components secure or tampering is evident.	8.2
N/A	Critical software shall be identified and secure. Identification readily available. Tampering evidenced for 'reasonable' time.	8.3
6.1/ 6.6/ 7.1.1/ 7.1.3/ 7.2	Data and critical parameters protected against corruption.	8.4
7.1.1/ 7.1.3/ 7.2	Display cannot be reset during use	8.5
	Information on/accompanying	**9**
9	Shall bear manufacturers mark or name and information in respect of its accuracy. Where applicable data on conditions of use, identity marking, number of type examination certificate	9.1
N/A	If too small, information placed on packaging	9.2
10	Accompanied by information on rated operating conditions, climatic, mechanical and EM environment classes. instruction operation and maintenance etc.	9.3
10	Utility meters do not require individual instruction manuals.	9.4
7.1.3	Decimal scale interval	9.5
N/A	Material measure	9.6
7.1.1/7.1.3	Units of measurement	9.7
9.4	Durability of marking	9.8
	Indication of result	10
7.1.3	Display	10.1
7.1.3	Clear indication	10.2
N/A	Hard copy	10.3

N/A	Direct trading	10.4
7.1.1/ 7.1.3	Indicator required	10.5
	Further processing of data	**11**
N/A	Durable record	11.1
N/A	Durable proof	11.2
Covered by whole standard	**Conformity evaluation**	**12**
		Annex MI 002
	Specific requirements gas meters	**Part I**
	Rated operating conditions	**1**
4.1/ 4.2/ 5.2	Flow range	1.1
4.4/ 5.6	T ≥ 40 gas	1.2
1 / 4.3/ 5.5/ 10	Gas family/MOP	1.3
4.4 / 5.6 / 5.7	T > 50 climatic	1.4
N/A	Limits of dc supply	1.5
	Maximum permissible errors	**2**
5.2/ 5.6/ 6.3.4/ 6.3.5	MPE	2.1
N/A	MPE TC	2.2
	Permissible effects of disturbances	**3**
1	EMC	3.1
N/A	Flow disturbances	3.2
	Durability	4
N/A	Durability – Class 1.5	4.1
8	Durability – Class 1	4.2
	Suitability	5
N/A	Mains power	5.1
N/A	Battery power	5.2
7.1.1	8000 h	5.3
5.8/ 10	Any position	5.4
7.1.4	Test element	5.5
9.2	Flow dir. marked	5.6
7.1	**Units**	**6**
	Specific requirements – Volume conversion devices	**Part II**
N/A	Base conditions for converted quantities	**7**
N/A	Maximum permissible error	**8**
N/A	Suitability	**9**
N/A	**Putting into use and conformity assessment**	**Part III**

	Putting into use	**10**
N/A		(a)
N/A		(b)
N/A		(c)
N/A	Conformity assessment	

Annex ZB
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 97/23/EC

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 97/23/EC (PED).

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZB confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZB — Correspondence between this European Standard and Directive 97/23/EC (PED)

Clause(s)/sub-clause(s) of this standard	Essential Requirements (ERs) of Directive 97/23/EC	
	Nature of Essential requirement	item
4.3 / 4.4/6.1/6.2.2 /6.2.3/6.2.5/6.2.6/ 6.3.5 / Annex D	Design loading	2.2.1
6.1/6.2.1/ 6.2.2 / Annex D	Design for adequate strength	2.2.2
6.1/6.2.1/ 6.2.2 / Annex D	Pressure containment and other loading aspects	2.2.3
6.1/6.2.1/ 6.3.1 ident 2 / Annex C	Experimental design method	2.2.4
6.1/6.2.3/ 6.2.4/ 6.2.5 / Annex D	Corrosion and other chemical attack	2.6
6.3.2/ Annex C	External fire	2.12
6.7 / Annex D	Permanent joining	3.1.2
6.2.6.2 / Annex D 2.2 indent 5	Non destructive tests	3.1.3
6.7 / Annex D 2.2 indent 6	Heat Treatment	3.1.4
Annex E// 6.3.1/6.3.3 / Annex D/ 2.3 // 2.4	Final inspection	3.2.1
6.3.1.3	Proof test	3.2.2
9	Marking and labelling	3.3
10.4	Operating instructions	3.4
6.2.6/ Annex F: Table F1 F2	Material for pressurized parts –appropriate properties	4.1 a
6.2.6	Material for pressurized parts-chemical resistant	4.1 b
6.2.2 / Annex F 6.2.6.1	(a) Values for design calculations	4.2
6.2.6.1	(b) Technical documentation elements	4.2
10.2 / 6.3.1.1 / 6.3.1.2	(c) Pressure equipment in categories III and IV	4.2

10.2/10.3/ /6.3.1.1 last indent	Conformity to required specifications	4.3
6.2.6.3.5 /Annex E Table E1, E2	Joint coefficients	7.2
6.3.1.3	Hydrostatic test pressure	7.4
Annex F / 6.2.6.1	Material characteristics	7.5

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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